CAN WE BRING CHEMISTRY BACK? EXPLORING THE POTENTIAL OF "GATEWAY ARTIFACTS" AT THE SCIENCE HISTORY INSTITUTE

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Abstract

For decades, science museums in Europe and America have been reducing the exhibition space they allocate to the presentation of historical chemical artifacts. This paper discusses several factors behind this concerning phenomenon, including changes to science museum revenue models, shifts in those museums' target audience profiles and interests, and the lack of aesthetic appeal exhibited by many chemical artifacts. It argues that the relative absence of these artifacts in museum displays deprives audiences of opportunities for unique, non-text-based learning experiences in settings that are especially conducive to engaging with material culture. The paper concludes by advocating for the design of single object "gateway artifact" exhibits that encourage museum visitors to examine and interrogate chemical artifacts from multiple perspectives; such exhibits could catalyze audience interest in the history of chemistry and provide museum visitors with critical tools for "unpacking" the scientific artifacts they encounter in museums and in their daily lives.

In 2025, Tsinghua University in Beijing will unveil its new "Tsinghua Science Museum," an institution whose projected size (it is planned to exceed 30,000 square meters) and programmatic ambitions will immediately place it in the upper echelon of university science museums worldwide. Informed by the leadership of Tsinghua's burgeoning Department of the History of Science, the Tsinghua Science Museum is being designed, in part, around a mandate to serve public audiences, with a focus on school-age children. Consequently, it will feature exhibitions on themes in contemporary science and innovation, driven by the latest in interactive exhibit technologies. Consistent with the aims of the historians of science who are guiding its development, however, the museum will also earmark considerable space for the presentation of artifacts drawn from the histories of Chinese, European, and American science.

With curation of their museum's future chemistry galleries in mind, Tsinghua's history of science faculty plan to build a core collection in this discipline; in their proposed long-rotation exhibition scheme, even artifacts that curators recognize could be intellectually stimulating but perhaps "visually disappointing"—the twentieth-century instruments or proverbial "black boxes" that challenge audiences with their inscrutability and modest aesthetic appeal—will be prominently featured. To this end, they have expressed interest in securing long-term loans of chemical apparatus and twentieth century analytical instruments from the Science History Institute's permanent collections. The Institute will be delighted to comply with this request for loans and for participation in collaborative projects with Tsinghua, encouraged in part by the realization that a major new museum is committed to borrowing, exhibiting, and programming around the types of historical chemical artifacts that, ironically and for many decades, have been gradually *disappearing* from exhibition halls in peer science museums in Europe and the United States.

This disquieting phenomenon has been well-chronicled by scholars in the history of science and museum studies, who have also commented on a parallel trend: the rapid global growth of science centers, whose exhibits and programming typically rely on interactives to engage their target youth audiences. Interactive-intensive exhibition tactics can, to be sure, support effective, constructivist pedagogical approaches to introducing people to abstract scientific concepts and practices, particularly as those concepts are embedded in contemporary environments and technologies. These approaches, however, have too often been pursued, wittingly or not, at the expense of presentations—and stories—that rely on historical artifacts to engage audiences.

Robert Anderson called attention to this development in his provocative 2016 Bunge Prize lecture, "Where Has All the Chemistry Gone?" (1). Anderson's question invites reflection (on why a shrinking population of small private museums and university collections, rather than large, nationally funded institutions, have become the last redoubts of historical chemical artifacts) as well as responses: what can we do to ensure that chemistry's material heritage is increasingly made visible and deployed to generate audience interest, questions, and perspectives rooted in the *history* of this discipline? If Tsinghua University's positive commitment to providing a museum platform for the history of chemistry is not to be anomalous, and if we are to "bring back" the chemistry that has been leaving our exhibition schemes, we must reckon with some of the reasons why chemistry's historical artifacts no longer have firm footing in today's museums.

Going, Going…Gone?

A steady decline in exhibition space devoted to historical artifacts in modern science museums over the course of the twentieth century has been well documented (2). Major, publicly accessible science and technology museums that made significant commitments to artifact presentation in the late nineteenth and early twentieth centuries (such as the Deutsches Museum, the Science Museum, London, and the Smithsonian Institution) did so primarily in the interest of educating audiences employed in, or inclined to pursue, careers in scientific and technical fields. This agenda complemented another, traceable in part to the influence of the international expositions and trade shows of the age: to use museums or museum-like displays to stimulate appetites for, and develop perspectives and skills that would further, scientific and technological innovation, and thus contribute to economic progress. Display schemes during this period tended to feature the presentation of massed collections of historical artifacts, chemical and otherwise, in large glass cases in what today might be referred to as "open storage" arrangements. Historical and contemporary objects were typically blended, and object labels tended to focus on the scientific principles and technical operations manifested in the apparatus and instruments, and on their utility, rather than on constructing narratives through which audiences might have viewed artifacts as emblematic of significant historical trends and developments.

As a case in point, Peter Morris's recounting of the evolution of exhibition schemes in the chemistry galleries at the Science Museum, London, through the twentieth century describes a development trajectory similar to those presented by several other science museums in Europe and the Unites States during this period (3). Morris describes the Science Museum's increasing interest, beginning mainly in the 1920s, in portraying the *history* of chemistry through artifacts; this approach culminated in the Museum's 1977 redisplay of more than 11,000 square feet of chemistry galleries. In these historically focused displays (complemented by nearby galleries devoted to the chemical industry and the public benefits it generated), chemistry was treated as a science with a history traceable to the ancient Egyptians, encompassing important contributions and related artifacts from the medieval and early modern periods and culminating with an illustration of major chemical developments of the twentieth century (4).

The Science Museum's 1977 chemistry galleries presented the visiting public with narratives of historical continuity, articulating how chemistry's past academic and research achievements had been instrumental to the development of useful industrial applications over time. These narratives were supported by and designed around the strategic acquisition and display of significant historical objects (particularly twentieth century instrumentation) by curator Anderson. In place for more than twenty years, the 1977 installation represented the apogee of the Science Museum's commitment to presenting the evolution of chemistry through historical artifacts. In 1999, however, these exhibitions and their artifacts were de-installed in favor of a new presentation, "The Chemistry of Everyday Life," which occupied only 13% of the original 1977 spaces devoted to the history of chemistry. This exhibition relied on a new suite of exhibits to focus on themes such as the development of chemistry since ~1800 (emphasizing quality control and biochemistry), contrasts between pure and applied chemistry, and the

presence of chemistry in contemporary life in unexpected places. The earlier focus on original artifacts as vehicles for carrying historical narratives yielded to a new reliance (at least initially) on interactive exhibits.

The interpretive arc traced by the development of the chemistry presentations at the Science Museum, London, was also in evidence at other peer science museums, such as the Museum Boerhaave and the Museum of Science, Boston, during the late twentieth century (5). As Anderson noted in his Bunge lecture, the world's major science museums have almost completely abandoned artifact-grounded presentations of the history of chemistry (and of the histories of other scientific disciplines as well), while the science centers that have been founded over the past fifty years primarily deploy interactive exhibits to illuminate STEM concepts, and the useful contemporary applications built upon them, with scant attention to the historical antecedents of those achievements. For chemistry, the task of preserving and interpreting the field's material heritage has largely fallen to a relative handful of small, specialized museums and university-based collections, which typically attract neither the resources nor the public attention necessary to meaningfully leverage historical collections for audience engagement.

Why Has the History of Chemistry "Left" Our Museums?

So, it appears that the history of chemistry has indeed been "leaving" our largest science museums—but why? Financial pressures have certainly played a role: state-sponsored institutions (particularly those in Europe and Asia) rely on governments for the bulk of their operating funds and government funders expect a return in the form of robust public attendance figures. The sobering fact is that museums dedicated solely or primarily to presentations on the history of chemistry typically draw very small audiences (6). In the United States, where government funding normally comprises only a small portion of operating budgets, philanthropy must make up the difference and philanthropy usually follows the turnstile. Museums and science centers believe that interactive-heavy exhibitions on recognizable themes are popular with their target audiences of children and their care givers, and attendance statistics and financial performance bear this out (7).

These financial realities are, of course, not just cause but also an effect of changes in audience composition and behavior. Science museums and centers have, for many decades, been gradually aiming their holdings and programs at non-expert audiences and have only recently focused on gathering data on the interests of the public (8). As Andrew Nahum observes, the increasing lack of sophistication in target audiences for science museums can be mapped onto a parallel shift in presentation tactics, from the earlier display of "study collections" of scientific artifacts (whose purposes and functions would have been apparent to scientists and practitioners) characteristic of galleries in the late nineteenth and early twentieth centuries, to the design of "games of communication" in recent decades, in which visitors need to be interactively entertained, as well as informed, to keep them coming in numbers (9).

Compounding the challenge of engaging scientifically unsophisticated audiences is the relative lack of superficial aesthetic appeal exhibited by chemistry's historical artifacts; chemistry, as numerous commentators have observed, lacks what Ad Maas refers to as "showpieces," or objects with "remarkable appearances" that have the "charisma" to attract viewers' attention, especially in the absence of familiarity with the objects' uses and purposes or sufficient contextualizing historical information (10). This is especially true of so much twentieth century instrumentation, for which the wryly ascribed term "black box" is often apt. Audiences not immediately familiar with the inner workings of these technologies are often bemused by their unadorned, sleek, modernist designs and the lack of surface indices of internal operations or instrumental uses. And these machines, often resistant to visual engagement and interpretation, are also tangible reminders of the relative inscrutability of modern chemistry itself, whose objects of research are complex and, unlike many of their counterparts in physics and biology, difficult to actually *see* or imagine.

This problem with visualizing the nature of chemistry itself is compounded by the fact that chemistry's physical manifestations in our lives and impacts on our behavior, while ubiquitous, are usually embedded in such a way that the presence of chemical phenomena all around us is not obvious. On this paradox, Ruth Jarman has observed that: "while chemistry makes an immense contribution to almost every aspect of modern living, a number of research studies have reported that many young people and adults fail to recognize its relevance to their daily lives" (11). Chemistry—its present and past—is literally and figuratively "hidden in plain sight."

The difficulty the public experiences in recognizing chemistry in daily life, let alone evidence of the history of chemistry, translates into challenges in the classroom and in museums. In recent years, educators and museum

professionals have consistently experienced resistance to well-intentioned schemes to introduce content on chemistry and its history into learning and cultural environments. At the heart of this public resistance to engagement with chemistry lies a perception that the field, along with being obscure and synonymous with abstraction and mathematical puzzles, is also partly responsible for many environmentally and socially harmful practices. Zaragozo and Fernandez-Novell remark on this phenomenon as they have observed it in Spanish secondary schools; they argue that misperceptions about the roles that chemistry plays in our lives and ignorance of the nuances of that interplay are, ironically, connected to the absence of history of chemistry content in courses, in museums, and in the mass media (12). Chemistry, in multiple respects, has an "image problem."

To be sure, historical artifacts can "earn" places in museum displays through more than just their accessible and charismatic appearances; they can also appeal to visitors by serving as what Ad Maas has called "key pieces" or reference points in compelling storylines about the histories of their fields (13). When the historiography of chemistry was focused primarily on chronological narratives of the field's "heroic" investigators and innovators and their notable achievements in the laboratory and in the public sphere, it was a relatively simple matter for museum curators to connect those major principals to iconic artifacts that gave tangible testimony to their accomplishments. This approach had, and still has, strong appeal for visitors and thus to museums concerned with selling tickets.

In recent decades, however, new historical methods and perspectives have emerged in academe that have both challenged and enriched traditional historiographical approaches in the history of science—and caused museum curators to take notice (14). Along with traditional figures and sites of investigation (such as professional scientists and laboratories), new actors and spaces (technicians and artisans, hospitals, factories, and domestic settings) have been introduced as objects of research, contributing to a multiplication of novel research sources and methods (15). This expansion of the scope of historiographical approaches to chemistry has also opened what is perceived as a philosophical "fault line" between historians: scholars and practitioners on one side of this divide are viewed as concentrating primarily on those questions, theories, practices, and knowledge products deemed "internal" to chemistry as an academic scientific discipline, those on the other side as engaging in research that focuses on understanding chemistry in the context of social and cultural discourses. Sensitive to this dynamic, many museum curators have begun to question the centrality of iconic historical artifacts to exhibition narratives, often producing exhibitions in which historical objects have their presence reduced or obviated altogether—and history of chemistry exhibitions have been no exception to this trend (16).

When the History of Chemistry Leaves Museums, What Do We Lose?

As chemistry's historical artifacts have gradually "gone missing" in contemporary museums and science centers, what have been the consequences for audiences with learning goals—and for curators keen to address their interests?

As Hasok Chang has recently observed, chemistry itself is very much about "making;" Berthelot once famously said that "chemistry creates its object." Few scientific fields can match chemistry in offering historical examples where practical applications, often driven by industrial and consumer demand, have yielded useful products that, in turn, have generated future questions for inquiry and subjects for investigation. And these products have been made available to the broad public through wide commercialization in fields such as pharmacology and nutrition and through a vast range of manufactured goods—artifacts that can be made accessible as learning tools to audiences through museum displays in ways that theories, equations, and small molecules cannot (17).

In-person, vivid encounters with artifacts in museums, and the generation of historical insights and knowledge creation that they can support, cannot be easily replicated by reading texts. Advocates for integrating material culture studies into the history of chemistry, such as scholars who have undertaken to re-create past experiments and historical laboratory conditions and processes, point out that "sensual experience can be difficult to transmit textually" and that "the sensual experiences of reproducing an experiment can thus offer the historian otherwise unobtainable hints regarding the origins of ideas, theories, conclusions, or the subsequent pathways of investigation followed by historical actors" (18). Thinking in a similar vein, Chang captures succinctly the potential for the history of chemistry to be presented in ways that appeal to a broad spectrum of audiences: "the sensory world of the chemist is luxuriously multi-modal" (19).

Education theorists have observed that non-traditional spaces for learning (i.e., sites outside conventional classrooms, lecture halls, or the covers of textbooks), that are well-suited to engaging audiences with the material culture of the history of chemistry, can make ideal venues for enacting object- and experience-rich "multi-modal" learning. Museums, for example, can offer visitors spaces to move around objects, the occasional integration of multi-sensory stimuli (engaging sounds, smells, and other changes in ambient environment), access to library materials that complement object-based experiences in the gallery, and even (increasingly) chances to handle and examine artifacts from multiple perspectives. The remaining, and relatively few, global institutions that collect, preserve, and program around the rare books, works of art, archival materials, apparatus, instruments, and realia of the history of chemistry can be ideal places for enacting multi-modal learning for curious audiences.

Bringing Chemistry Back: Exploring the Potential of "Gateway Artifact" Exhibits

Given the capacity constraints—financial, human, spatial, and technological—faced by the small museums and university collections that still harbor and program around historical chemical artifacts, how might we develop strategies for the curation and continued presentation of such artifacts that are viable and deliver audience impact? This is a question faced by the Science History Institute, which, alongside its substantial and important library and archival collections, operates a museum dedicated to chemical history, with particular emphasis on nineteenth and twentieth century stories of chemistry's industrial applications and instrumentation. Through this museum, the Institute remains committed to the active collection and preservation of chemical artifacts, both for the benefit of current researchers and audiences, as well as of those in generations to come.

The Institute's museum also supports, and periodically refreshes, a permanent collection presentation, *Making Modernity*, originally curated in 2008. This exhibition features a visually compelling design and strikes an audience-friendly balance between artifacts, graphics and text. And yet, despite intelligent and creative efforts on the part of curators to connect with walk-in, lay visitors (as well as chemists and industry practitioners, the primary audience targets for the original design), this permanent exhibition faces many of the aforementioned challenges in its quest to engage the scientifically curious but largely uninformed public (20).

To address these challenges, museums like the Institute's should consider their strengths and limitations, not purely in a vacuum, but sensible of the resources and programming offered by the cultural institutions in their "peer ecosystem." Curators-cum-storytellers at small institutions can be excused for succumbing to the desire to present artifact-packed, ostensibly "comprehensive" exhibitions, but this impulse should be curbed in favor of exploring content niches and narrative approaches not already well covered by peers, as well as by adopting a "less is more" approach to narrative scope and numbers of objects presented. Moreover, like its peers, the Institute should be sensitive to the need to respect "sunk" investments in existing exhibition infrastructure; the immense expense associated with overhauling permanent exhibitions when interpretive fashions change places a premium on taking a different approach—generating cost-effective, innovative tactics for engaging, enlightening, and entertaining audiences that complement, rather than necessarily replace, the permanent exhibition status quo.

This stance urges on small but chemistry-rich museums the imperative of operating more like the historical laboratories they often describe and interpret, embracing a spirit of experimentation in their curatorial work. For museums open to curatorial experimentation, scaling audience impact will likely be achieved not solely through engaging the visitors coming through their own doors, but rather through the introduction of interpretive models that other peer institutions may be inclined to emulate and scale further.

With these parameters in mind, the Science History Institute museum will embark on a modest experiment in engaging its core audience (members of the public over twelve) in an exercise in interpretive skills building. Our proposed project will be the construction of a permanent, single-artifact exhibit, to be positioned in the museum's entrance hall, where it will be encountered and engaged by all Institute patrons; it will, in this setting, serve as their introductory, framing experience of the Institute. Every object that serves as the subject of this exhibit will be drawn from the museum's chemical artifacts collections; choices will range from the charismatic and prepossessing (Eighteenth-century brass balances? Early modern alembics?) to the notoriously inscrutable twentieth century "black boxes," of which the Institute has an enviable collection. As each selected, single artifact will be positioned just out of the reach of visitors, a first encounter with it will encourage initial engagement with its formal features and aesthetic dimensions and an appreciation of its "thingness" and auratic qualities.

This initial opportunity to visually appreciate the artifact will be augmented by multiple opportunities to explore and interrogate it through the provision, in the artifact's surround, of a diverse array of supplemental prompts and interpretive technologies. These prompts and technologies will run the gamut from low- to high-tech, inviting visitors to choose the learning/entertainment affordances with which they are most intrigued or comfortable: laminated cards with printed questions and answers; three-dimensional object replicas that can be opened and manipulated; smart phone- and tablet-based tutorials, digital animations, and augmented reality object overlays; and virtual reality projections and holograms. The technologies will vary and will provide visitors with answers to myriad questions about the featured artifact: What does it do? What theoretical or practical problem(s) was it designed to address? How was it manufactured? By whom? Who paid for it? What is it made of? What was, and is, its scientific, industrial, and/or monetary value? What technology(ies) preceded it? What technology(ies) followed it? Over time, an initial list of questions will be supplemented or replaced by others suggested by visitors, encouraging them to participate with curators in the process of interrogating, "unpacking," and making meaning from these artifacts (21).

This "360 degree" approach to investigating, understanding, and taking intellectual and aesthetic pleasure in a single artifact, no matter how inaccessible or unappealing it may appear at first glance, will be designed, it is hoped, to serve multiple purposes. It will, firstly, try to acquaint visitors with critical tools via exposure to a range of ways to "question" chemical artifacts. In so doing, it will help them develop conversance with perspectives that reflect the interests of scientists and historians of scientific innovation and discovery, as well as those of social historians and students of material culture.

It is also anticipated that, by taking time at the beginning of their visits to immerse themselves in a single artifact, visitors will learn to *slow down* their encounters with all the exhibits in the Institute's museum and, by extension, in other museums. People who have been conditioned (by years of visits to retail settings, as well as to museums) to traverse galleries rapidly, pausing only briefly to digest object labels or cast superficial glances at artifacts, may grow newly comfortable lingering over displays and engaging in critical explorations of their contents. They may learn, in a sense, to see less and yet see more, simultaneously.

Indeed, encouraging chemically curious visitors (as well as those initially indifferent to chemistry's charms) to "see more" will be an overarching aim of what we might call our "Gateway Artifact" project. Institute patrons who, upon arrival, are receptive to this multi-media, multi-valent exercise in looking and learning will be encouraged to regard all the chemical artifacts in our exhibits not as impenetrable objects but as gateways—portals into myriad avenues of inquiry and stories about chemistry's past and present. The goal will be to offer information and perspectives that intersect at least a few of the interests and life experiences that each visitor brings with them to the museum. In this way, we hope to provide interpretive models for our visitors' future encounters with chemistry's material culture, whether those take place in museums or via experiences of the chemistry embedded in their daily lives (22). We are optimistic that this project will be one vehicle through which the Institute (and our peer stewards of chemistry's history) can help "bring chemistry back" for museum audiences. By catalyzing a spirit of inquiry in our visitors, and spurring them to see our exhibits as useful points of departure for lifetimes of learning about chemistry, we aim to generate fresh interest in the history of this fascinating but obscure science.

References and Notes

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3. P. Morris, "The Image of Chemistry Presented by the Science Museum, London in the Twentieth Century: An International Perspective," *HYLE—International Journal for the Philosophy of Chemistry*, **2006**, *12(2)*, 215-239.
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5. For accounts that discuss similar shifts in exhibition design, from reliance on historical scientific artifacts to their replacement by interactives-driven, STEM-focused exhibits at the Museum Boerhaave and at the Museum of Science, Boston, see A. Maas, "Introduction: History of Science Museums between Academics and Audiences," *Isis*, **2017,** *108*(2), 360-365; and V. Cain, "Present Tense:

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21. The multiple questions-based visitor engagement approach described here is partly indebted to several interpretive models developed by historians of material culture. See particularly J. Hennigar-Shuh, "Teaching Yourself to Teach with Objects," *J. Educ. (Nova Scotia)*, **1982**, *7*(4), 8-15, which contains Shuh's famous list of "50 Ways to Look at a Big Mac Box." See also Sebastian Smee's review of Harvard University's 2011 multi-disciplinary "Tangible Things" exhibition: S. Smee, "These Are Just a Few of Their Quirkiest Things," *Boston Globe*, March 6, 2011.
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